

REISSUE DECLARATION

We, as the below-named inventors, hereby declare that our residences, post office addresses and citizenships are as stated below adjacent our names, that we verily believe we are the original, first and joint inventors of the invention described and claimed in Letters Patent No. 5,940,268 issued August 17, 1999 and in the specification filed April 1, 1997, serial number 08/831,430, and for which invention we solicit a reissue patent; that we have reviewed and understand the contents of the specification filed herewith, including the claims; that we acknowledge our duty to disclose information of which we are aware which is material to the examination of this Reissue Application in accordance with Title 37, Code of Federal Regulations, §1.56(a); and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States prior to filing of Application Serial No. 08/831,430 (from which Patent 5,940,268 issued) by us or our legal representatives or assigns, except as follows:

Japanese Patent Application No. 8-082306 filed April 4, 1996.

The priority of Japanese application no. 8-082306 was claimed in said U.S. application and are also hereby claimed in this Reissue Application and a certified copy is available in the parent file.

We further declare that we believe said Letters Patent is, through errors which arose without deceptive intent on the part of the applicants, wholly or partially inoperative by reason of claiming more or less than we had a right to claim in the patent. The errors relied

upon as the basis for reissue include the inclusion of the language "a plurality of fins" in all of the independent claims of the parent patent, whereas independent claims 12, 22, 25, 29, and 42 of this reissue application omit such elements. Thus, the parent patent claims are narrower than necessary to distinguish over the prior art in at least this respect.

All errors in the patent which are being corrected in the present reissue application up to the time of filing of this Declaration arose without any deceptive intention on the part of the applicants.

We hereby appoint the following as our attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office:

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We, as the undersigned inventors, further declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United

States Code and that such willful false statements may jeopardize the validity of the reissue application or of any reissue patent to issue thereon.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

53206-03
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reissue

In re the Application of

Inventors: Masaharu MIYAHARA et al.

Serial No.: Reissue Application of
U.S. Patent No. 5,940,268
(Issued: August 17, 1999)

Filed: TBD

For: HEAT SINK AND ELECTRONIC DEVICE EMPLOYING THE SAME

STATEMENT UNDER 37 CFR 3.73(b)

Assistant Commissioner for Patents
Washington, DC 20231

Dear Sir:



Pursuant to MPEP §1.410.01, the undersigned, a duly authorized representative of Matsushita Electric Industrial Co., Ltd., the Assignee of the entire right, title and interest in U.S. Patent No. 5,940,268, hereby establishes the Assignee's ownership interest in this patent by specifying that the evidence of such ownership interest is recorded at Reel 9654, Frame 0567 of the U.S. Patent and Trademark Office microfilm files. A copy of the recorded Assignment is attached.

For and on behalf of

MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.

H. Kitagawa

(Signature)

Hidemasa Kitagawa
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August 6, 2001

(Date)

(Title)

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a heat sink for cooling a semiconductor element which emits much heat such as a micro processing unit (referred to as an MPU hereinafter).

2. Description of the Prior Art

Heat sinks have been used for cooling semiconductors and the like which emit much heat. Recently, in particular, a fan-motor-integrated heat sink incorporated with a small fan is used for coping with the high heat emission of the MPU etc.

Conventional heat sinks will be described hereinafter. FIG. 8 is a perspective view of a conventional heat sink and FIG. 9 is a cross sectional view of the conventional heat sink.

In FIGS. 8 and 9, reference numeral 81 denotes an MPU that is a high-exothermic semiconductor element, 82 a heat sink substrate which is mounted on the MPU 81, 83 radiator fins, 84 driving means such as a motor or the like, 85 a fan and 86 a structure such as the casing of a notebook-type personal computer etc. for defining a space above the heat sink.

The operation of a conventional fan-motor-integrated heat sink having the aforementioned structure will be described hereinafter. Heat emitted from the MPU 81 is transmitted to the heat sink substrate 82 and the radiator fins 83. Air flow generated by the fan 85 rotated by the driving means 84 is taken in between the structure and the upper surface of the heat sink as shown by an arrow A and passes among the radiator fins 83 while carrying off heat therefrom to be vented from the side surface thereof as shown by an arrow B.

The aforementioned conventional structure had a problem that it was impossible for thin devices such as the notebook-type personal computer limited in thickness to secure a sufficient space for taking in air from above the heat sink and consequently to secure a sufficient cooling performance. Although the entire heat sink may be made thin for securing sufficient space, a motor capable of rotating the fan to generate a sufficient amount of air flow for cooling the device required a certain degree of thickness because of the structure of its bearing and coil, so that the motor was structurally limited in being made thin.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a fan-motor-integrated heat sink capable of effectively supplying cooling air flow to an element even if the same is a heat emitting element such as an MPU etc. employed by a thin device which cannot secure a sufficient space above the heat sink.

In order to attain the above object, the present invention obtains a sufficient space for taking in air between the upper surface of the heat sink and the casing of a device by making the height of the fan and those of the fins of the heat sink lower than the height of the upper surface of the fan driving means such as a motor which is structurally limited in thickness relative to the heat sink substrate. Furthermore, the heat sink substrate and the fins are formed such that air is vented only in one direction to compensate for the reduction of cooling performance caused by miniaturizing the fan and the fins of the heat sink substrate, and a cover is provided on the inlet side to prevent the vented air from being taken in.

This structure enables arranging a structure above the heat sink nearly as low as the height of the motor and consequently mounting the heat sink on a thin device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a heat sink according to a first embodiment of the present invention;

FIG. 2 is a plan view of the heat sink according to the first embodiment of the present invention shown in FIG. 1;

FIG. 3 is a cross-sectional view of the heat sink according to the first embodiment of the present invention;

FIG. 4 is a perspective view of a heat sink according to a second embodiment of the present invention;

FIG. 5 is a cross-sectional view of the heat sink according to the second embodiment of the present invention;

FIG. 6 is a perspective view of a heat sink according to a third embodiment of the present invention;

FIG. 7 is a view showing the inside of an electronic device which incorporates therein the heat sink according to the third embodiment of the present invention;

FIG. 8 is a perspective view of a conventional heat sink; and

FIG. 9 is a cross-sectional view of the conventional heat sink.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will be described hereinafter with reference to FIGS. 1 to 7.

FIG. 1 is a perspective view of a heat sink according to a first embodiment of the present invention, FIG. 2 is a plan view of the heat sink according to the first embodiment of the present invention, and FIG. 3 is a cross-sectional view of the heat sink according to the first embodiment of the present invention.

In FIGS. 1, 2 and 3, reference numeral 1 designates a heat emitting element such as an MPU or the like on which a heat sink is mounted for cooling, the heat emitting element 1 having, for example, in case of an MPU, usually a shape of a quadrangle such as a square, a rectangle or the like having a side of 40 mm to 50 mm. Numeral 2 is a heat sink substrate, which is substantially square-shaped in outline almost similar to the heat emitting element 1 and which may be made of resin such as plastics without being limited to metals such as aluminum, brass, etc. so long as it is high in thermal conductivity as a member. The heat sink substrate 2 may be in outline of other shapes such as a circle as needed. The heat sink substrate 2 having a flat edge surface is mounted on the heat emitting element 1 according to a fixing method, using a bond, hooks, screws, etc. such that the flat side thereof is in contact with the upper surface of the heat emitting element 1. A side wall 3 is provided on three other edge surfaces of the heat sink substrate 2, the side wall 3 being provided along the edge surfaces of the heat sink substrate 2 at the outer side thereof and being substantially circular around the rotating axis of a fan 7, described later, at the inner side thereof. The side wall 3 defines the direction of air flow and the blowing-out direction thereof and serves as a fin as well. An edge of the heat sink substrate 2 where no side wall 3 is provided becomes an outlet 4. Numeral 5 designates a plurality of radiator fins, which are provided substantially in parallel to the flowing out direction of air in the vicinities of the outlet 4 while substantially in circular arcs each having a predetermined length with its center at the rotating axis of the fan 7, described later, in other places.